Bridge Pier Local Scour Depth (CSU / HEC-18)

Local scour depth at a bridge pier from its width, length, attack angle, flow depth and velocity by the Colorado State University equation used in HEC-18.

Method: Colorado State University pier scour equation

Input parameters

Unit system: SI

Parameter	Value	Unit
Pier width	1.2000	m
Pier length	8.0000	m
Angle of attack of the flow	10.0000	°
Flow depth just upstream	4.0000	m
Mean velocity just upstream	2.0000	m/s
Pier nose shape	Round nose or cylinder (1.0)	
Bed condition factor 1.1 for clear-water, plane bed and small dunes; up to 1.3 for large dunes.	1.1000	

Calculated results

Parameter	Value	Unit
Froude number upstream	0.31933	
Angle of attack factor	1.6409	
Local scour depth	4.0414	m
Scour depth relative to pier width	3.3678	

Notes for this case

• The CSU equation y_s = 2.0 $K_1K_2K_3$ a (y_1/a)^0.35 Fr_1^0.43 gives the equilibrium local scour at a pier. A skewed pier presents a wider face: K_2 = (cos θ + (L/a) sin θ)^0.65 with L/a no more than 12; when the attack angle exceeds 5° the nose-shape factor K_1 is taken as 1.0. For round-nosed piers aligned with the flow HEC-18 caps the scour at 2.4a (Froude ≤ 0.8) or 3.0a. Add contraction scour and long-term degradation for the total scour depth.

Formula and method

$$\frac{y_s}{a} = 2.0 K_1 K_2 K_3 \left(\frac{y_1}{a}\right)^{0.35} Fr_1^{0.43}, \quad K_2 = \left(\cos\theta + \frac{L}{a}\sin\theta\right)^{0.65}$$

Variables

a	Pier width	m
L	Pier length	m
θ	Angle of attack of the flow	rad
y_1	Flow depth just upstream	m
V_1	Mean velocity just upstream	m/s
K_1	Pier nose shape	-
K_3	Bed condition factor	-
Fr_1	Froude number upstream	-
K_2	Angle of attack factor	-
y_s	Local scour depth	m
y_s/a	Scour depth relative to pier width	-

Method and standards

Pier scour.

Assumptions and limits

- Non-cohesive bed; equilibrium scour; no debris.

References

Colorado State University pier scour equation

Report details

Report reference	FCC-65KY-53P2 (the same inputs always give the same reference)
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Release checks	3 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/civil/hydraulics/bridge-pier-scour-csu

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.